

REMARKS

In view of the above amendments and the following remarks, reconsideration and further examination are respectfully requested.

I. Amendments to the Claims

Claims 3, 5, 6, 8, 9 and 11 have been amended to eliminate multiple dependent claims that depend from other multiple dependent claims. Specifically, claim 3 has been amended so as to depend only from claim 1, claims 5, 6, and 8 have been amended so as to depend from claims 1, 2, and 3, respectively, and claim 11 has been amended so as to depend only from claim 9.

It is also noted that claims 1-12 have been amended to make a number of editorial revisions thereto. These editorial revisions have been made to place the claims in better U.S. form. Further, these editorial revisions have not been made to narrow the scope of protection of the claims, or to address issues related to patentability, and therefore, these amendments should not be construed as limiting the scope of equivalents of the claimed features offered by the Doctrine of Equivalents.

II. Claim Objections

The Examiner has commented on page 2, lines 3-5 in the Office Action that “Claims 4-6, 8, and 9 are objected to under 37 CFR 1.75(c) as being in improper form because a multiple dependent claim cannot depend upon any other multiple dependant claim.” As mentioned above, claim 3 is dependent upon claim 1 alone, claims 5, 6, and 8 are dependent from claims 1, 2, and 3, respectively, and claim 11 is dependent upon claim 9 alone. Thus, each of claims 4-6, 8 and 9

are no longer dependent on multiple dependent claims

As a result, withdrawal of the above-mentioned objection is respectfully requested, since claims 4-6, 8, and 9 comply with the formality requirements of 37 CFR 1.75(c).

III. 35 U.S.C. § 112, First Paragraph Rejection

The Examiner has alleged on page 2, lines 6-10 in the Office Action that claims 1 to 12 of the present application fail to comply with the enablement requirement under 35 U.S.C. § 112, first paragraph. The Applicant respectfully traverses this rejection.

Concerning Definition of X_{max}

The Examiner asserts on page 3, lines 5-8 in the Office Action that “the variable X_{max} is ambiguous as to whether it is describing the available Lithium content of the battery, as described by the Li_xC₆ (see spec. pg. 2, lines 12-15), or whether it is describing the fractional discharge capacity, which is what the equation appears to calculate as X_{max} as (see spec. pg. 4, line 3).” However, as described on page 2, lines 12-14 in the specification of the present application, the definition of X_{max} is “the maximum value X can have when the graphite which stores lithium by charging represented by Li_xC₆ that is, the maximum value of the charging depth”. Furthermore, as described on page 3, line 28 of the specification of the present application, “ $X_{max} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$ ” is a formula for calculating the above-defined X_{max}. Thus, there is no ambiguity in the relationship between the definition of X_{max} and the formula “ $X_{max} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$ ” for calculating X_{max}. The reason why the maximum value of X in Li_xC₆ can be calculated using “ $X_{max} =$

$T(\text{mAh})/(Z(g) \times 372(\text{mAh/g}))$ ” is as follows:

Lithium-intercalated graphite is represented by the general formula Li_xC_6 , which x (the quantity of Li) increases in a charge process, decreases in a discharge process, and varies within a range of $0 \leq x \leq 1$. Then, the value of x in a state where the charge process is completed is the maximum value x_{max} . T in the formula denotes the discharge capacity of the battery when discharged from the completely charged state ($x = x_{\text{max}}$ in Li_xC_6) to a completely discharged state ($x=0$ in Li_xC_6). The specification of the present application describes that T is a sum of C1-C4 discharge capacities. The reason why the sum of the discharge capacities of C1-C4 is the discharge capacity from $x = x_{\text{max}}$ to $x = 0$ in Li_xC_6 will be explained in details in the section below identified as “Method for calculating T .” The theoretical capacity of graphite C_6 is 372mAh/g , which corresponds to the discharge capacity of C_6 per gram when discharged from $x = 1$ to $x = 0$ in Li_xC_6 . Accordingly, the discharge capacity of Li_xC_6 per gram when discharged from $x = 1$ to $x = 0$ in Li_xC_6 is $372(\text{mAh/g}) \times x_{\text{max}}$. Because the battery contains $Z(g)$ graphite, the discharge capacity $T(\text{mAh})$ of the battery can be found using the formula as follows:

$$(i) \quad T(\text{mAh}) = Z(g) \times (372(\text{mAh/g}) \times x_{\text{max}}).$$

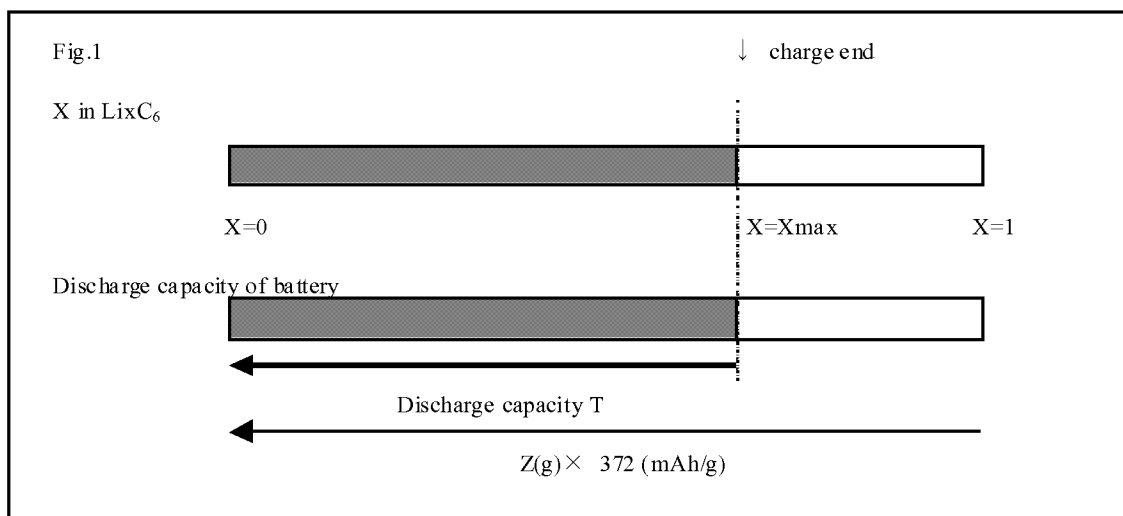
By transforming formula (i) into a formula for finding x_{max} , the following formula is obtained:

$$(ii) \quad x_{\text{max}} = T(\text{mAh}) / (Z(g) \times 372(\text{mAh/g})).$$

x_{max} is equal to a ratio of the discharge capacity T from $x = x_{\text{max}}$ to $x = 0$ in Li_xC_6 to the theoretical capacity of the negative electrode in the battery $Z(g) \times 372(\text{mAh/g})$. As an aid for deeper understanding, the relationship between these ratios will be shown in Fig. 1 below.

Thus, the definition of x_{max} and the relationship between x_{max} and its calculation

formula $X_{\max} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$ is clearly described in the specification of the present application, and there is no ambiguity in the description of the specification of the present application.



Interpretation of Maximum Charge Depth

The Examiner asserts on page 3, lines 8-11 in the Office Action that “In addition, X_{\max} could reasonably be interpreted as meaning the battery’s maximum discharge depth, which the specification appears to describe as the “maximum charging depth”(see spec. Pg. 2, lines 13-14).” However, the Applicant respectfully submits that X_{\max} is described to be a “maximum charge depth,” and the manner of calculating X_{\max} , which is described in the description in the specification of the present application, has no discrepancy in that X_{\max} is the maximum charge depth. There is no ambiguity in the description of the specification of the present application. It is unclear how the “maximum discharging depth” indicated by the Examiner is defined, and it is impossible to understand in which reasoning the Examiner’s interpretation was made.

Therefore, it is impossible to state any remarks on the assertion as above. If the Examiner maintains the above-mentioned rejection, Applicant respectfully requests the Examiner to present the definition of “maximum discharge depth” and details of the reasoning in which such an interpretation was made.

Manner of Calculating T

The Examiner has alleged on page 3, lines 11-17 in the Office Action that “Furthermore, the manner in which T (the variable used to calculate X_{\max}) is calculated is unclear. The specification only describes T as being set to the total discharge capacities C1, C2, C3 and C4. It is unclear whether the specification means that T is set to the sum of C1-C4, the average of C1-C4, of whether there are several data sets wherein there are several value T that should be calculated for different discharge rates.” In this section, the manner of calculating T using C1-C4 will be explained in detail. Furthermore, a detailed description of the manner of calculating T using C1-C4 will provide an understanding of “the reason why the sum of the C1-C4 discharge capacities is the discharge capacity of Li_xC_6 from $X = X_{\max}$ to $X = 0$ ” as mentioned in the section “Definition of X_{\max} .”

As explained in the section “Definition of X_{\max} ,” in order to calculate X_{\max} using the formula $X_{\max} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$, it is necessary to find the discharge capacity T from $X = \max$ to $X = 0$ in Li_xC_6 . The discharge capacity T can be found by completing charging to $X = X_{\max}$ in Li_xC_6 under a predetermined charging conditions and, thereafter, discharging to $X = 0$. In this connection, because the discharge capacity T is the battery capacity between $X = 0$ and $X = X_{\max}$ in Li_xC_6 , the quantity of charge electricity from $X = 0$ to $X = X_{\max}$ in Li_xC_6 is

equal to the discharge capacity T.

When discharging to the completely discharged state ($X = 0$ in Li_xC_6) in the process of finding the discharge capacity T, it is necessary to consider a capacity decrease caused by an IR drop. An IR drop is the voltage drop that is represented by a product of a discharge current I and a battery resistance R. The IR drop makes the actual battery voltage lower than the open circuit voltage. A high-rate (e.g., C1-rate in the specification of the present application) discharge causes a larger voltage drop due to the IR drop, and thus the battery voltage rapidly reaches the discharge end voltage. Accordingly, the discharge capacity at only the high rate is smaller than T. That is, it is impossible to discharge completely to $X = 0$ in Li_xC_6 by the high-rate discharge alone. Therefore, in order to discharge to $X = 0$ in Li_xC_6 , a low-rate (e.g., C2-C4 rates in the specification of the present application) discharge is executed after the high-rate discharge.

Processes of the C2-C4 rate discharges is as follows: take 10-minute pause after the C1-rate discharge, so that the battery voltage returns to the open circuit voltage and becomes higher than the discharge end voltage, 2.75 V; thereafter, without charging, discharge at the C2 rate from this battery voltage to the discharge end voltage, 2.75 V; after the C2-rate discharge, in the similar process, execute the C3-rate discharge; and further, after the C3-rate discharge, execute the C4-rate discharge.

Because the voltage drop due to the IR drop reduces as the discharge rate is lowered, a complete discharge to $X = 0$ in Li_xC_6 is enabled by discharging at the C2-C4 rates. The sum of the discharge capacities of the C2-C4 rate discharges is equal to the capacity loss caused by the IR drop in the C1-rate discharge. By adding the sum of the C2-C4 rate discharge capacities to the C1-rate discharge capacity, an exact value of the discharge capacity T from $X = X_{\text{max}}$ to $X =$

0 in Li_xC_6 can be found. This is the reason why the discharge capacity T, which is the sum of the C1-C4 discharge capacities, is the discharge capacity from $X = X_{\text{max}}$ to $X = 0$ in Li_xC_6 . While the Examiner has asserted that the manner in which T is calculated using C1-C4 is unclear, the Applicant submits that now the above explanation has made it clear that T is the sum of the discharge capacities found using C1-C4. Furthermore, it is also clear that T is the sum of C1-C4 from the description on page 3, lines 27-28 of the specification of the present application stating that “the total discharge capacity of the discharge capacities C1, C2, C3 and C4 thus obtained is set to T.”

Thus, the definition of X_{max} , and the relationship between X_{max} and the calculation formula “ $X_{\text{max}} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$ ”, is clearly described in the specification without any ambiguous points. Applicant submits that it can be sufficiently understood from the description of the specification as originally filed. Furthermore, while the manner of calculating T, which is used in the calculation formula “ $X_{\text{max}} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$,” is also clearly described in the specification, it has been additionally explained as above. In regard to the definition of X_{max} , the formula for calculating X_{max} , “ $X_{\text{max}} = T(\text{mAh}) / (Z(\text{g}) \times 372(\text{mAh/g}))$,” and the manner of calculating T, the specification has no ambiguity. Therefore, Applicant submits that X_{max} recited in claims 1-3 and 12 of the present application can be found by a person skilled in the art without excessive experiments, and the enablement requirement under 35 U.S.C. §112, first paragraph is satisfied.

As a result, withdrawal of the above-mentioned 35 U.S.C. § 112, first paragraph rejection is respectfully requested.

IV. 35 U.S.C. § 103(a) Rejections

The Examiner has asserted that “Jacobs et al. (U.S. 5,721,067) discloses that the ratio of the theoretical capacity of the negative electrode plate to the theoretical capacity of the positive electrode plate, defined as $R_{N/S}$ in the claim, may be between 0.85 and 1.15” (page 6, line 7 from bottom in the Office Action) and that “Naruaki et al. (JP 2000-195558) teaches a method of charging a Lithium Manganese composite battery wherein the charge depth, X_{max} is 50% ... Naruaki teaches that maintaining the charge depth at around 50% can make greatly reduce capacity deterioration” (page 6, line 2 from bottom in the Office Action). The Examiner then has alleged that the invention of claims 1 and 12 of the present application would have been obvious by combining these two cited references. Applicant disagrees on this issue.

The Examiner has asserted that “If $R_{N/S}$ is between 0.85 and 1.15 then X_{max} at 50% would satisfy conditions (1) and (2) of claim 1” (page 6, line 1 from bottom to page 7, line 2 in the Office Action). However, combination of Jacobs et al. with Naruaki et al. would not satisfy the configuration of any one of claims 1 and 12 of the present application. This is because the numerical value, 50% disclosed by Naruaki et al. cannot be assumed as X_{max} that is a maximum charge depth of the negative electrode. Applicant explains the reason as follows.

Naruaki et al. discloses that “in control of charge-discharge, this value should be taken as a theoretical capacity of the positive electrode so that charge-discharge is performed in a region corresponding to 50% or less of this capacity” (paragraph 0033) and that “by performing charge-discharge in the region of 50% or less of the theoretical capacity of the positive electrode, capacity deterioration of nonaqueous electrolyte can be significantly reduced” (paragraph 0040). Then, this configuration of Naruaki et al. and the configurations of claims 1 and 12 of the

present application will be hereinafter compared.

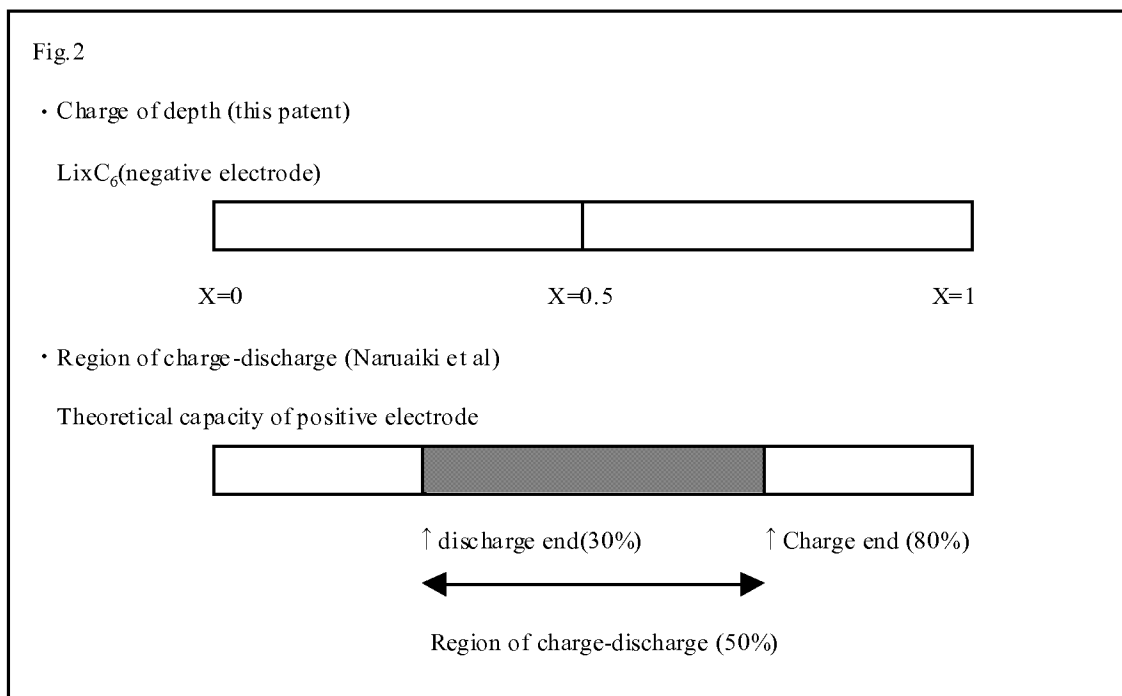
The configuration of Naruaki et al. defines the region of charge-discharge of the positive electrode (the region of charge-discharge will be described below). On the other hand, claims 1 and 12 of the present application define the charge depth of the graphite composite negative electrode. The invention of claims 1 and 12 of the present application relates to the negative electrode, which is different from the electrode which Naruaki et al is directed to. As a first difference, claims 1 and 12 of the present application and Naruaki et al. are different in their directed electrodes.

The second difference is as follows. Naruaki et al. discloses that “charge-discharge is performed in a region corresponding to 50% or less of the theoretical capacity of the positive electrode,” wherein the region defining the numeric value is the region of charge-discharge between a charge end state and a discharge end state (paragraph 0009 of Naruaki et al.) For example, in a case where the charge depth of the positive electrode at the charge end voltage is 80%, while the charge depth of the positive electrode at the discharge end voltage is 30%, the region of charge-discharge is the difference therebetween, 50%.

On the other hand, in a case where the charge depth of claims 1 and 12 of the present application is assumed to be 50%, it represents the region between $X=0$ and $X=0.5$ in Li_xC_6 . Because the region of charge-discharge of Naruaki et al. is a region where the battery is used, the discharge end state is not always $X=0$ in Li_xC_6 . Accordingly, the charge depth recited in claims 1 and 12 of the present application and the region of charge-discharge disclosed by Naruaki et al. are different in their regions defining the numeric values. The difference between the charge depth and the region of charge-discharge are illustrated below in Fig. 2. As the second

difference, claims 1 and 12 of the present application and Naruaki et al. are different in their regions defining the numeric values.

These above two differences are the reason why 50% disclosed by Naruaki et al. cannot be assumed to be Xmax of claims 1 and 12 of the present application. Accordingly, even if 50% disclosed by Naruaki et al. would be used to realize the conditions (1) and (2) of claims 1 and 12 of the present application, it would not satisfy the configurations of any one of claims 1 and 12 defining the “charge depth of the negative electrode.” Naruaki et al., which is directed to the different electrode and has the different region of the numeric value definition, cannot be a basis of the conclusion that the configuration of claims 1 and 12 is obvious.



The Examiner has asserted in the Office Action that “Naruaki teaches a method of charging a Lithium Manganese composite battery wherein the charge depth, Xmax is 50%”

(page 6, line 2 from bottom) and that Naruaki et al. also uses lithium-manganese composite oxide. However, the lithium-manganese composite oxide of Naruaki et al. and lithium manganese composite oxide are absolutely different compounds. Applicant explains this as follows.

Naruaki et al. discloses the lithium manganese composite oxide represented by chemical formula LiMnO_2 and $\text{LiMn}_{1-x}\text{MxO}_2$ (paragraph 32). On the other hand, the chemical formula of the lithium-manganese composite oxide recited in claims 1 and 12 of the present application is LiMn_2O_4 (page 2, lines 17-21 of the specification of the present application). Thus, it is found that they are compounds different in their chemical formulas. The crystal structure of LiMnO_2 disclosed by Naruaki et al. has a layer rock salt type structure (claim 3 of the cited reference), which theoretical capacity is 286mAh/g (the cited reference [0033]). The crystal structure of LiMn_2O_4 recited in claims 1 and 12 of the present application has a spinel type structure (claims 1 and 12 of the present application), which theoretical capacity is 148mAh/g (page 2, lines 22-23 of the specification of the present application).

Also in the view of the crystal structure and the theoretical capacity, LiMnO_2 disclosed by Naruaki et al. and LiMn_2O_4 recited in claims 1 and 12 of the present application are absolutely different active materials. Naruaki et al. absolutely fails to disclose the lithium-manganese composite oxide, LiMn_2O_4 having the spinel structure. It is a matter of course that the region of charge-discharge whereby capacity deterioration can be reduced varies depending on the positive-electrode active material. Therefore, it is impossible to draw upon Naruaki wherein LiMnO_2 is used and thereby to come up with the invention of claims 1 and 12 of the present application using LiMn_2O_4 , which crystal structure and the theoretical capacity are

absolutely different from those of LiMnO_2 .

Neither of Jacobs et al. and Naruaki et al. discloses the charge depth of the negative electrode. Even if “the ratio of the theoretical capacity of the negative electrode to the theoretical capacity of the positive electrode, defined as $R_{N/S}$ in the claim may be between 0.85 and 1.15” disclosed by Jacobs et al. would be publicly known, it would be impossible to lead the configuration of “A charging method, ... wherein a charge depth of the negative electrode satisfies following Conditions (1) and (2)” by combining Jacobs et al. with Naruaki et al. that defines the region of charge-discharge in the positive-electrode theoretical capacity and uses the absolutely different positive-electrode active material. Therefore, Applicant submits that claims 1 and 12 of the present application would not have been obvious in view of any combination of Jacobs and Naruaki.

Regarding dependent claims 8-11, which were rejected under 35 U.S.C. § 103(a) as being unpatentable over Jacobs and Naruaki in view of various combinations of Shuji (JP 2000-067863) and Daido (U.S. 6,818,352) (secondary references), it is respectfully submitted that the secondary references do not disclose or suggest the above-discussed features of independent claim 1 that are lacking from the Jacobs and Naruaki. Therefore, no obvious combination of Jacobs, Naruaki and Shuji with Daido would result in, or otherwise render obvious, the invention recited independent claim 1 and the claims that depend therefrom.

Furthermore, there is no disclosure or suggestion in Jacobs, Naruaki, Shuji and/or Daido or elsewhere in the prior art of record which would have caused a person of ordinary skill in the art to modify Jacobs, Naruaki, Shuji and/or Daido to obtain the invention of independent claims 1 and 12. Accordingly, it is respectfully submitted that independent claims 1 and 12 and claims

2-11 that depend therefrom are clearly allowable over the prior art of record.

V. Conclusion

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance and an early notification thereof is earnestly requested. The Examiner is invited to contact the undersigned by telephone to resolve any remaining issues.

Respectfully submitted,

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